

**Set Up:**

**PVP Acceptance Test**

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# SET UP – PVP Acceptance Test

**Note:**

Use the **DESIGN 03-Pump Sizing Tool** for confirming the total head (m or feet), the recommended PV module capacity (kWp) and flow rate (liters or gallons / minute) and to re-calculate the actual installation.

## Introduction

The results of the acceptance test show the difference between the designed and the actual performance of the pumping system. The following procedure describes a relatively simple acceptance test which can be carried out after installation or at any time during operation.

The acceptance test can be performed using the basic monitoring system described in the Module **GET INFORMED**; additionally, a solar irradiance sensor and a water level dipper to measure the dynamic water level are required.

## Procedure

The following steps will be carried-out during the acceptance procedure:

a) Check the orientation of the solar generator

b) Measure the solar irradiance, S

c) Calculate the solar generator’s electrical output power, Pel.

d) Measure and calculate the total pumping head, HT

e) Measure the actual water flow, Qmeas.

f) Compare the measured value with the theoretical water flow

The measurements b), d), and e) should be carried-out within a short time interval with clear sky conditions, without clouds during measurement. At least, two acceptance tests are advisable, measuring at high irradiance (800 – 1000 W/m2) levels and low irradiance levels (approx. 500 W/m2).

## Measure azimuth and elevation angles of the solar generator

In the northern hemisphere solar panels would face South to maximize the energy yield. Consequently, in the southern hemisphere solar panels would face North. Deviations from true north/south are possible but will result in a reduced energy yield. The azimuth angle of the solar generator can be measured with a magnetic compass, or smart phones with built-in compass application.

Solar modules are always inclined at the tilt angle **α** which allows for optimizing the solar radiation capture on the panel surface. The tilt angle **α** should be selected in accordance with the latitude in which the pumping system is installed. Typical values for the tilt angle can be estimated to:

**α** = absolute value of geographic latitude + / - 10º

For applications with focus in winter months, the tilt angle might be increased up to +10º, for summer months the tilt angle might be reduced up to -10º. But to allow rain water and accumulated dirt to run off the panel surface, the tilt angle should be **at least 15°**, even if the system is installed close to the equator. The tilt angle **α** can be measured with a protractor. Smart phone applications for inclination measurement are a convenient alternative.

## Measure the solar irradiance, S

For measuring the solar irradiance use a calibrated sensor, normally a calibrated solar cell, connected to a digital tester, see Figure 1. Exposed to the sun, the solar sensor delivers a DC voltage, which increases direct proportionally to the solar irradiance. The sensor’s manufacturer provides a calibration factor which allows to calculate the actual irradiance value; the sensor shown in Figure 1, as an example, has a calibration factor of 96 mV / 1000 W/m2.

Install the solar sensor in the inclined solar generator plane, take the tester’s reading in mV and calculate the corresponding actual solar irradiance in W/m2.

Note: During measurement, avoid any shading of the solar sensor.



Source: GIZ/ Reinhold Schmidt, 2015

Figure 1: Measuring solar irradiance

1. Calculate the solar generator’s electrical output power, Pel.

Using the measured value of solar irradiance, the solar generator produces an electric power, which can be calculated to:

Ppeak

Pel. = FCP x x S

1000 W/m2

The correction factor FCp is estimated by using the following values of ambient temperature:

|  |  |
| --- | --- |
| **Tamb [°C]** | **FCp** |
| 25 | 0,90 |
| 30 | 0,85 |
| 35 | 0,80 |

Ppeak is the peak power as indicated on the solar panels

1. Measure and calculate the total pumping head, HT

The total pumping can be determined by measuring the water pressure at p1 and the dynamic water level Hd, see Figure 2:

HT  = Hd + Hp1 in meter



Source: GIZ/ Reinhold Schmidt, 2015

Figure 2: Measuring the total pumping head

Note: To measure the dynamic water level in the well, it is recommended to use a water level dipper as shown in Figure 3. In case of pumping from a surface water source, the dynamic water level usually shows only little variation and should be measured directly. To measure the water pressure p1, it is highly recommended to use a new, calibrated pressure gauge; in that case, the installed pressure gauge can be replaced for this measurement.



Source: Solinst Canada Ltd., 2015

Figure 3: Water level dipper

**Measure the actual water flow, Qmeas.**

There are two possibilities to determine the actual water flow: take the reading of the installed water flow meter or use a bucket, as big as possible, measure the bucket’s volume and time to fill it, as shown in Figure 4. Both measurements lead to very precise data.



Source: GIZ/ Reinhold Schmidt, 2015

Figure 4: Measuring water flow

1. Compare the measured value with the theoretical water flow

Final step is to determine the theoretical water flow Qi with the given values of solar irradiance and total pumping head and compare this value with the measured water flow Qmeas.

For calculating the theoretical water flow, use the manufacturer’s pump curves for the specific motor pump installed. Select the corresponding PQH curve in the diagram, determine the actual operating point with the given electrical power on the x-axis and read the resulting water flow Qi, as indicated schematically in Figure 5.

The pump performance curves below list flow rate on the vertical axis, power on the horizontal axis; each line represents a different total dynamic head (TDH). For a particular TDH, the

possible flow rates of each pump can be determined. The power required to achieve each flow/head combination is found on the horizontal axis



Figure 5: Determining the theoretical water flow value

The measured water flow compared with the theoretical value should be within the following limits (+/- 15 % ):

0,85 x Qi < Qmeas. < 1,15 x Qi

If the measured water flow is out of the given limits, the following steps are recommended:

* Verify all measured and calculated data and repeat measurement, if necessary.
* Check the three-phase motor cable wiring in the inverter/control: reverse any two of the three wires and measure again.
* Check the radiation sensor, pressure gauge and water flow meter and measure again.
* Contact the installation company and/or supplier, if water flow remains below specified limits